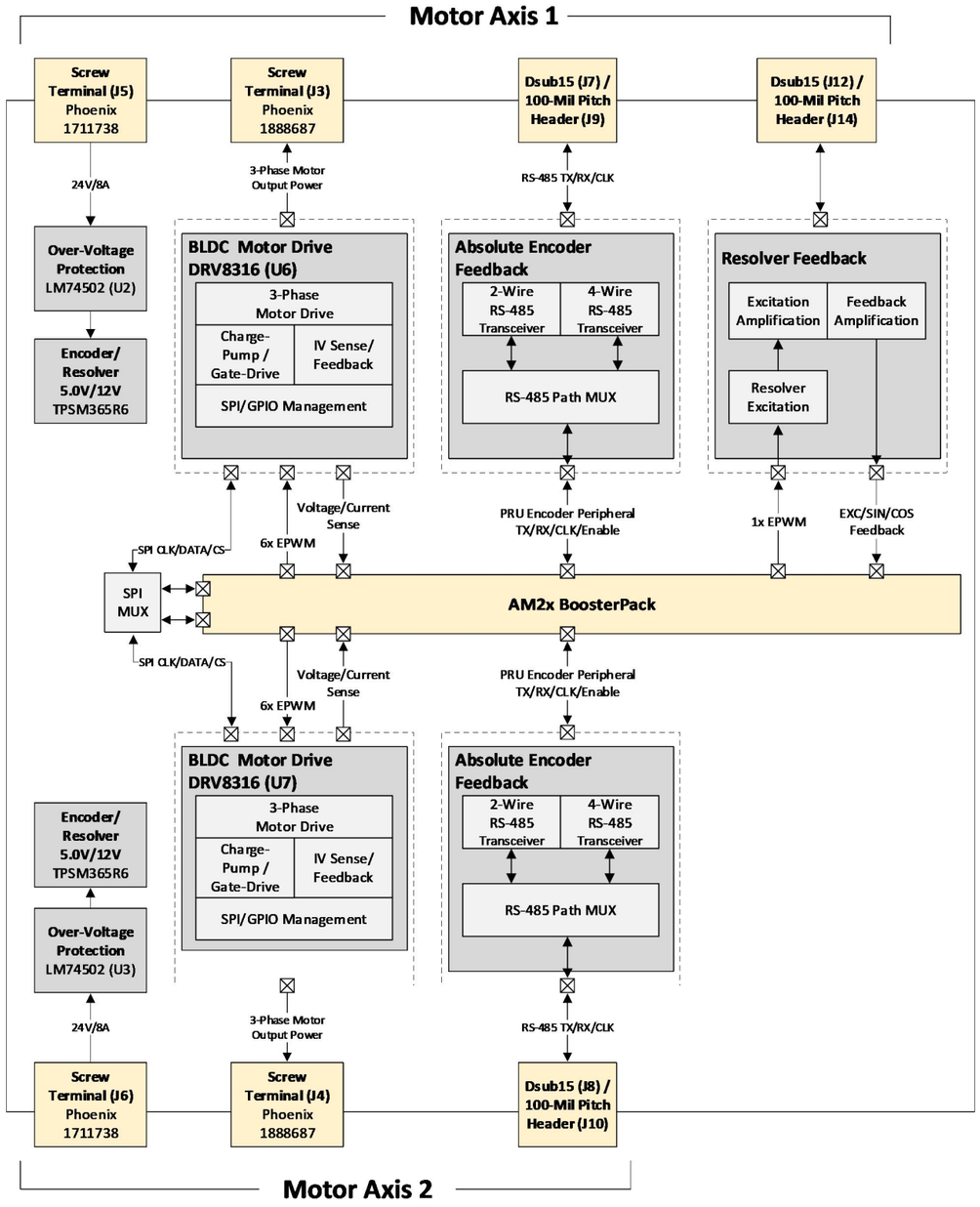
AM2x 2-Axis, BLDC Servo Drive BoosterPack

Revision History				
Rev	ECN #	Approved Date	Approved by	Notes
E2	N/A	2023-06-15	R. Rosales	First public release version E1 errors fixed and small feature addtions

System Diagram



Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/15/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]			Sheet: 1 of 17
Drawn By:		File: PROC152_Coverpage.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

TEXAS INSTRUMENTS
http://www.ti.com

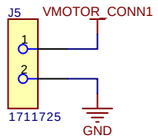
Power, Motor Drive, and Position Feedback Connectors

Axis 1

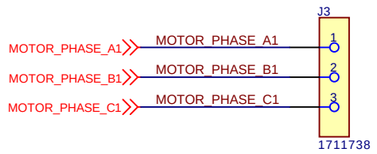
Motor Power

9V-24V, 8A Operation

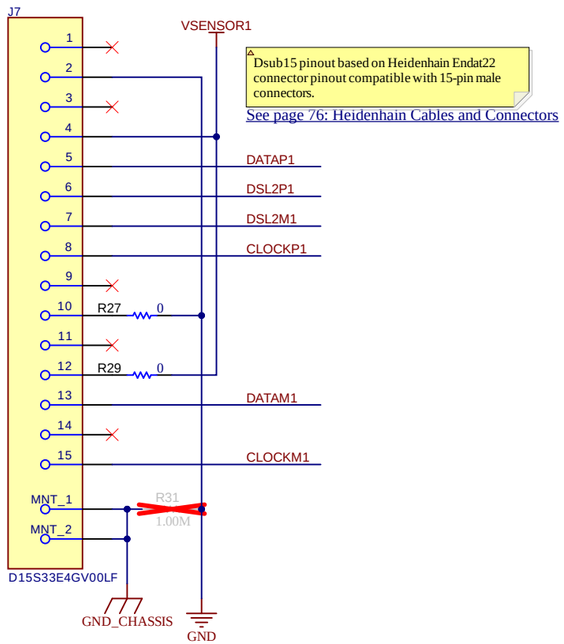
DO NOT EXCEED 48V Input



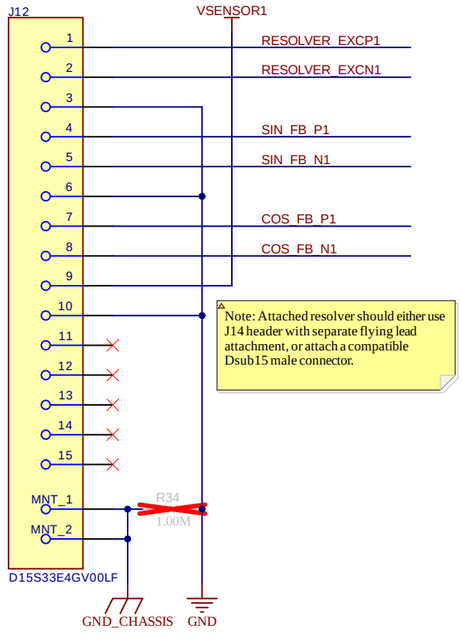
Motor Drive Output

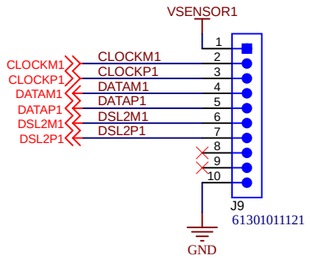


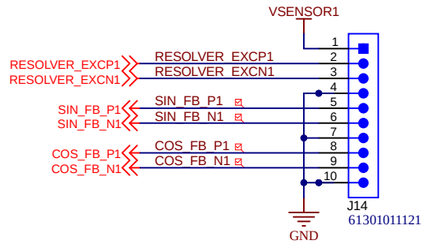
Encoder Feedback



Resolver Feedback





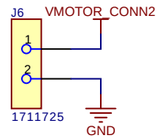


Axis 2

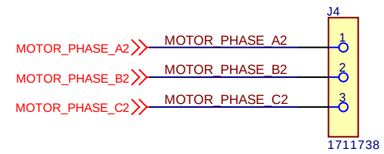
Motor Power

9V-24V, 8A Operation

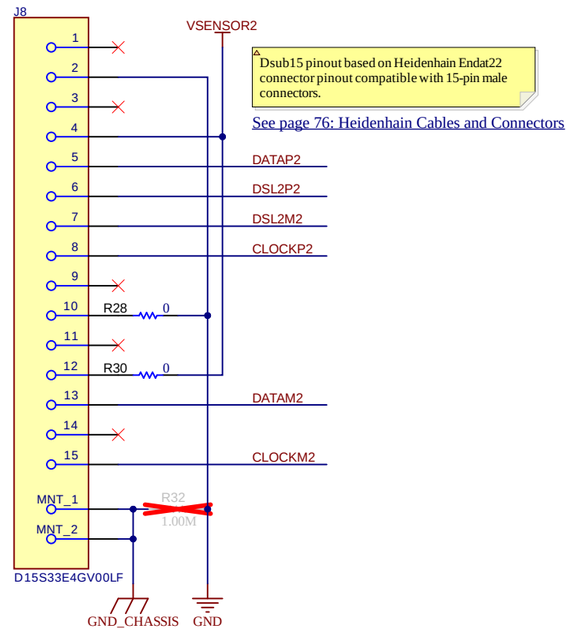
DO NOT EXCEED 48V Input

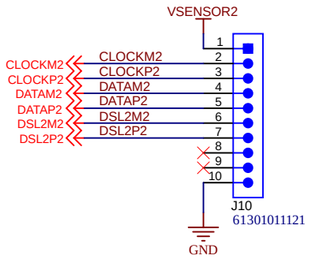


Motor Drive Output



Encoder Feedback





Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/15/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title: Power, Motor Drive, and Position Feedback Connectors	
SVN Rev: 0c65c49446c640714d1d00[illegible][Locally Modified]			Sheet: 2 of 17
Drawn By:		File: PROC152_Connectors.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

http://www.ti.com

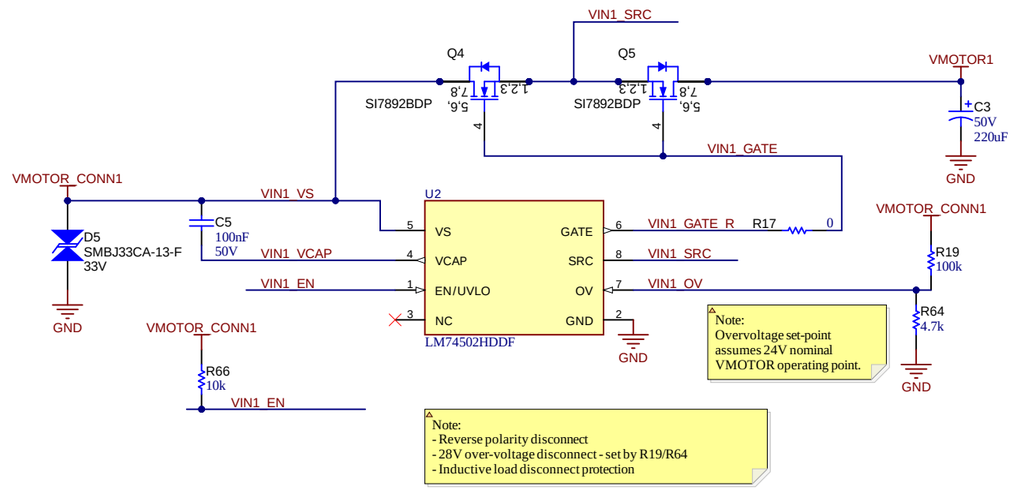
LM74502: 3.2-V to 65-V industrial RPP controller with load disconnect and OVP

System Power

Over-voltage, Over-current and Reverse Polarity Protection

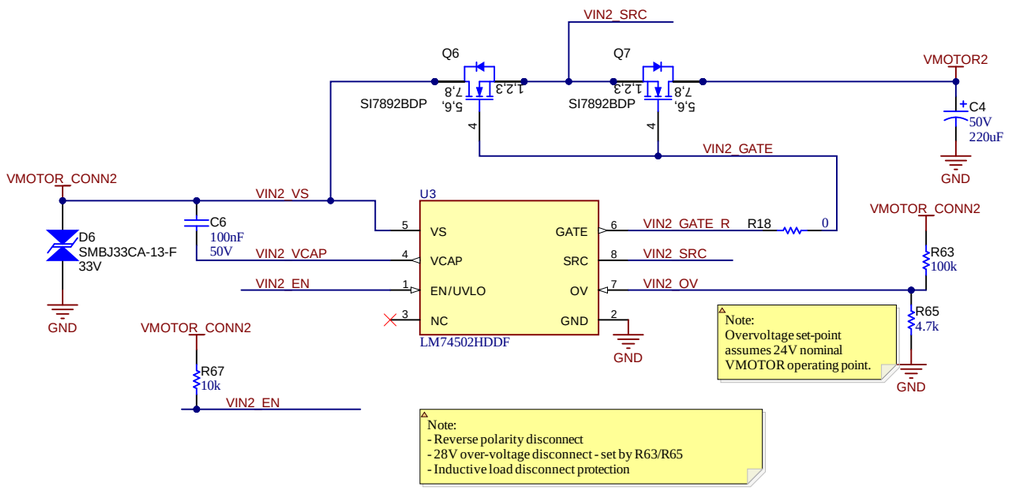
Axis 1

WARNING: OVERVOLTAGE SHUTDOWN AT 28V



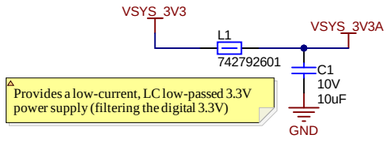
Axis 2

WARNING: OVERVOLTAGE SHUTDOWN AT 28V

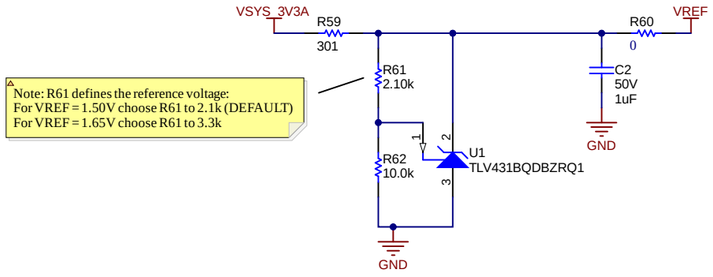


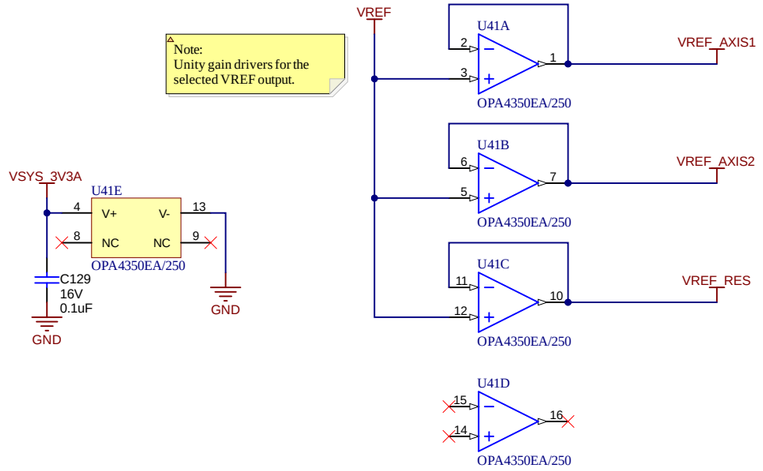
System analog power filtering, VREF Generation

System Analog 3.3V, 200mA



System ADC VREF





Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/8/2023
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Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]	Sheet: 3 of 17	
Drawn By:	File: PROC152_System_Power.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

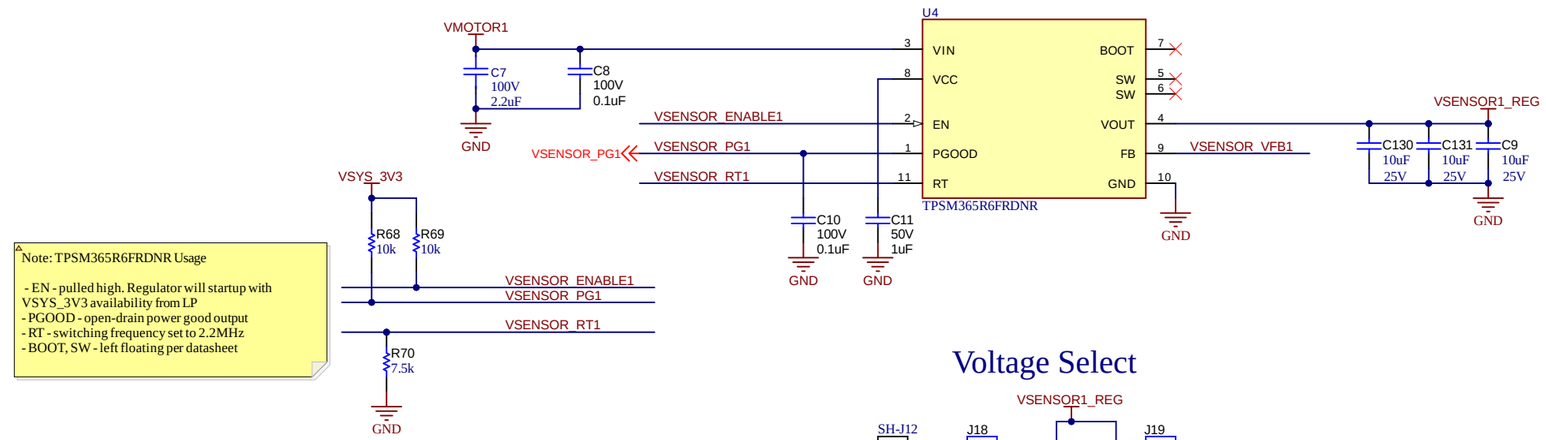
http://www.ti.com

TPSM365R6: 3-V to 65-V input, 1-V to 13-V output, 0.6-A synchronous buck converter power module

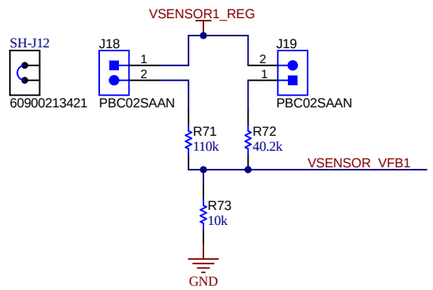
TPS22810: 18-V, 3-A, 79-mΩ load switch with adj. rise time and adj. output discharge

Encoder/Resolver Power - Axis 1

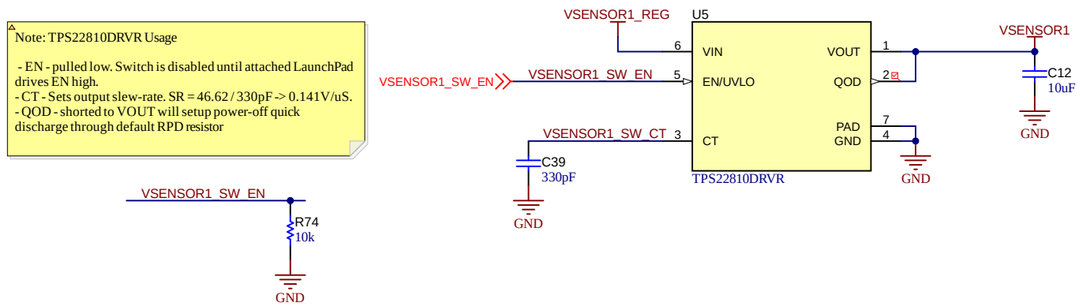
Encoder/Resolver Power 1
5V or 12V, 600mA



Voltage Select



Encoder/Resolver Load Switch



Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 5/31/2023
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Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]001			Sheet: 4 of 17
Drawn By:		File: PROC152_Sensor_Power1.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

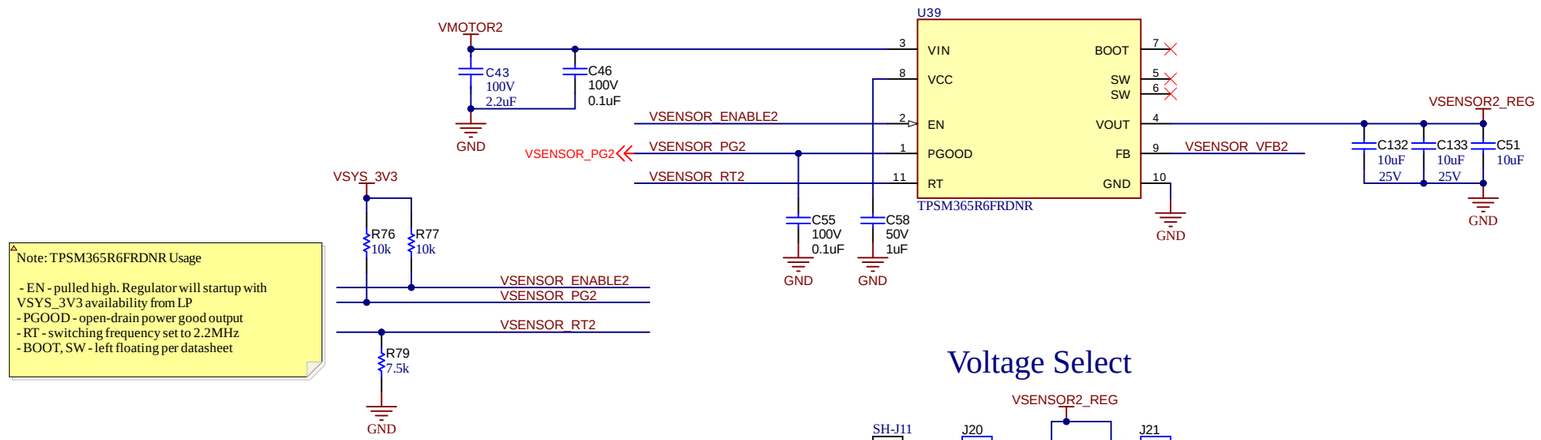
TEXAS INSTRUMENTS
http://www.ti.com

TPSM365R6: 3-V to 65-V input, 1-V to 13-V output, 0.6-A synchronous buck converter power module

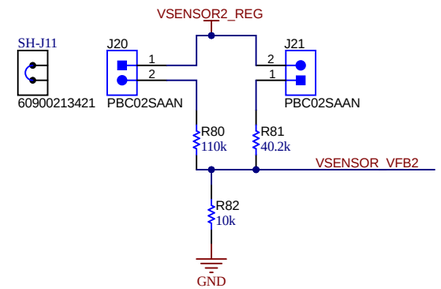
TPS22810: 18-V, 3-A, 79-mΩ load switch with adj. rise time and adj. output discharge

Encoder Power - Axis 2

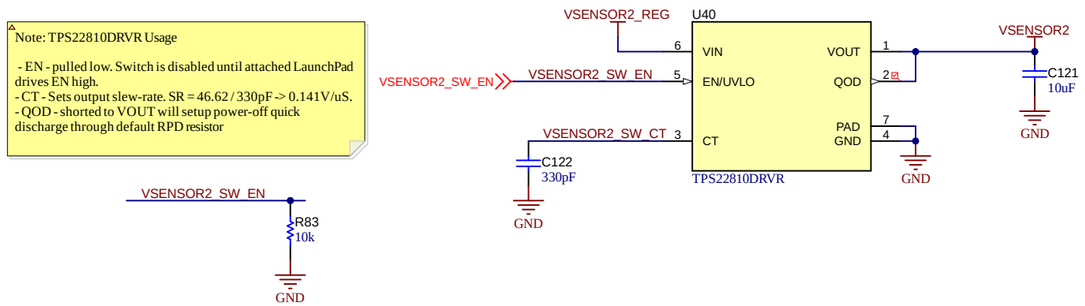
Encoder/Resolver Power 2
5V or 12V, 600mA



Voltage Select



Encoder/Resolver Load Switch



Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 3/7/2023
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Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00			Sheet: 5 of 17
Drawn By:		File: PROC152_Sensor_Power2.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

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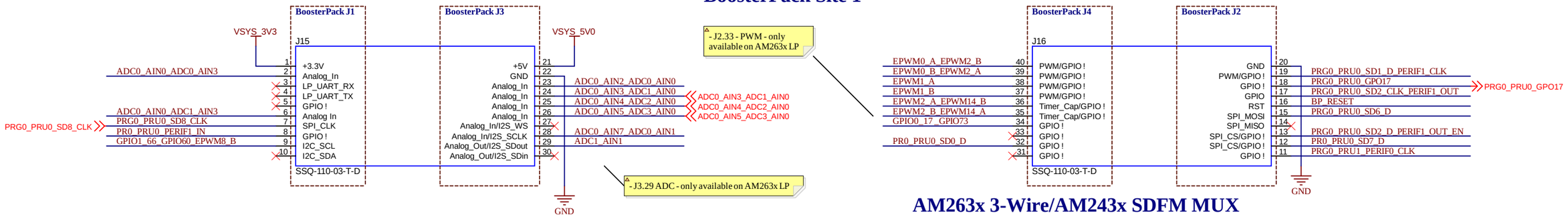
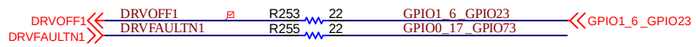
BoosterPack Headers

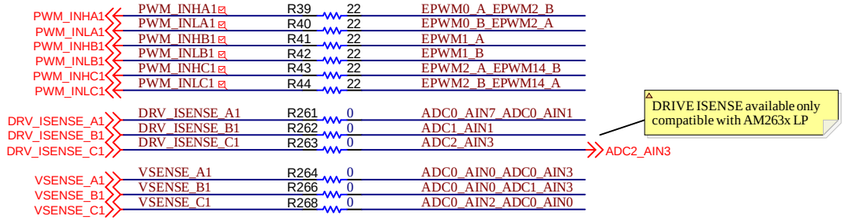
BoosterPack Site 1

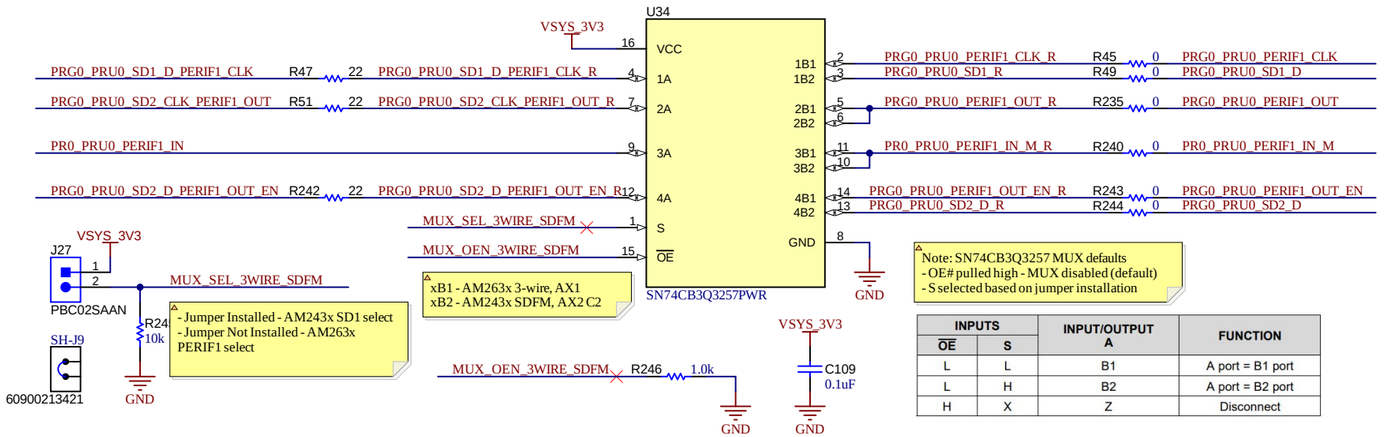


AM263x 3-Wire/AM243x SDFM MUX

Axis 1 - DRV Signals

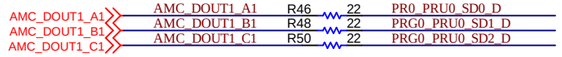






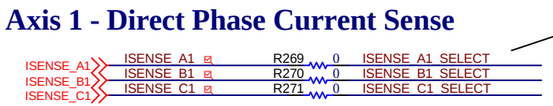
INPUTS		INPUT/OUTPUT	FUNCTION
$\overline{OE}$	S	A	
L	L	B1	A port = B1 port
L	H	B2	A port = B2 port
H	X	Z	Disconnect

Axis 1 - SDFM Phase Current Sense



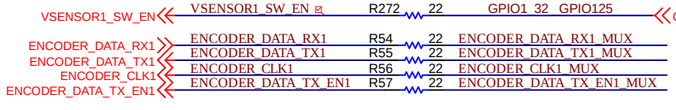
See associated spreadsheet for PRU mapping

Axis 1 - Direct Phase Current Sense



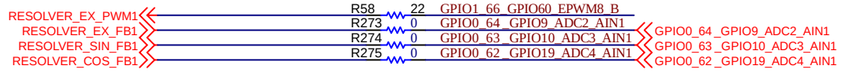
In-phase motor current feedback only compatible with AM263x LP

Axis 1 - Encoder Data Signals



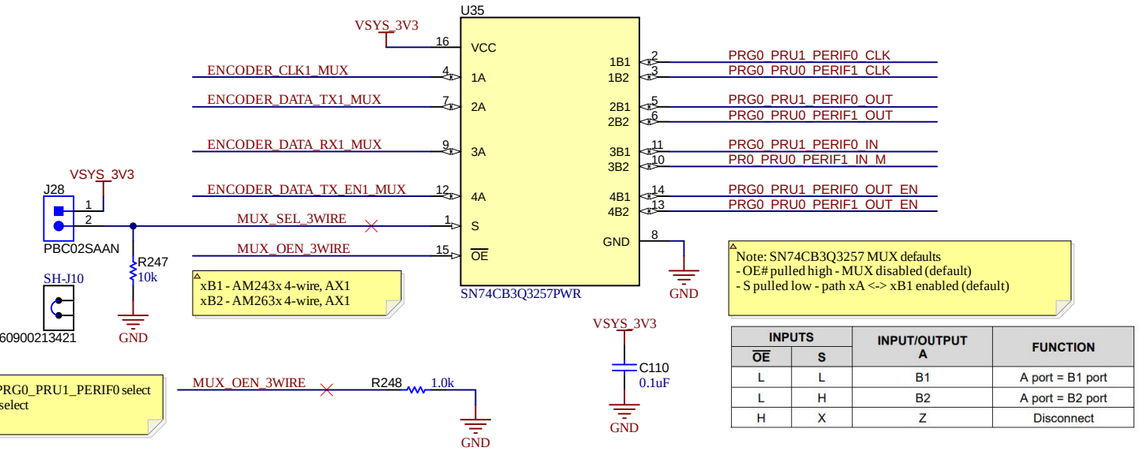
See associated spreadsheet for PRU mapping

Axis 1 - Resolver Feedback



Resolver positional feedback only compatible with AM263x LP

AM263x 4-Wire/AM243x 4-Wire MUX



INPUTS		INPUT/OUTPUT	FUNCTION
$\overline{OE}$	S	A	
L	L	B1	A port = B1 port
L	H	B2	A port = B2 port
H	X	Z	Disconnect

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 5/31/2023
TID #: N/A	Project Title: BP-AM2BLDCSERVO	
Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00318bbd9a26212ab001		Sheet: 6 of 17
Drawn By:	File: PROC152_Boosterpack_Header1.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

Texas Instruments
http://www.ti.com

BoosterPack Headers

Boosterpack Site 2

- J5.42 ADC - only available on AM263x LP

BoosterPack J5

J1

		41	+3.3V
ADC2_AIN3	ADC2_AIN3	42	Analog_In
	GPIO1_11_GPIO21	43	LP_UART_RX
	PRG0_PRU0_SD3_D	44	LP_UART_TX
PRG0_PRU0_GPO19	PRG0_PRU0_GPO19	45	GPIO !
		46	Analog In
	SPI_CLK	47	SPI_CLK
		48	GPIO !
GPIO1_6_GPIO23	GPIO1_6_GPIO23	49	I2C_SCL
	GPIO1_64_GPIO24	50	I2C_SDA

SSQ-110-03-T-D

VSYS_3V3

BoosterPack J7

		61	+5V
		62	GND
	GPIO0_64_GPIO9_ADC2_AIN1	63	Analog_In
	GPIO0_63_GPIO10_ADC3_AIN1	64	Analog_In
	GPIO0_62_GPIO19_ADC4_AIN1	65	Analog_In
		66	Analog_In
	PRG0_PRU1_PERIF0_OUT	67	Analog_In/I2S_WS
	PRG0_PRU1_PERIF0_OUT_EN	68	Analog_In/I2S_SCLK
	PRG0_PRU1_PERIF2_CLK	69	Analog_Out/I2S_SDout
	PRG0_PRU1_PERIF2_IN	70	Analog_Out/I2S_SDin

VSYS_5V0

GND

PRG0_PRU1_PERIF0_OUT_EN → PRG0_PRU1_PERIF0_OUT_EN

GPIO0_64_GPIO9_ADC2_AIN1 → GPIO0_64_GPIO9_ADC2_AIN1

GPIO0_63_GPIO10_ADC3_AIN1 → GPIO0_63_GPIO10_ADC3_AIN1

GPIO0_62_GPIO19_ADC4_AIN1 → GPIO0_62_GPIO19_ADC4_AIN1

BoosterPack J8

J2

	EPWM13_B	80	PWM/GPIO !
	EPWM13_A	79	PWM/GPIO !
	EPWM3_B	78	PWM/GPIO !
	EPWM3_A	77	PWM/GPIO !
	EPWM9_B	76	Timer_Cap/GPIO !
	EPWM9_A	75	Timer_Cap/GPIO !
	GPIO1_78_GPIO124	74	GPIO !
GPIO1_32_GPIO125	GPIO1_32_GPIO125	73	GPIO !
	PRG0_PRU1_PERIF2_OUT	72	GPIO !
PRG0_PRU1_PERIF0_IN	PRG0_PRU1_PERIF0_IN	71	GPIO !

SSQ-110-03-T-D

BoosterPack J6

		60	GND
		59	PWM/GPIO !
	SPI_CS0	58	GPIO !
	PRG0_PRU1_PERIF2_OUT_EN	57	GPIO
	BP_RESET	56	RST
	SPI_D0	55	SPI_MOSI
	SPI_D1	54	SPI_MISO
	GPIO1_40_GPIO67	53	SPI_CS/GPIO !
		52	SPI_CS/GPIO !
		51	GPIO !

GND

Axis 2 - DRV Signals

DRVOFF2	DRVOFF2	R7	22	GPIO1_64_GPIO24
DRVFAULTN2	DRVFAULTN2	R8	22	GPIO1_40_GPIO67

PWM_INHA2	PWM_INHA2	R1	22	EPWM3_A
PWM_INLA2	PWM_INLA2	R2	22	EPWM3_B
PWM_INHB2	PWM_INHB2	R3	22	EPWM9_A
PWM_INLB2	PWM_INLB2	R4	22	EPWM9_B
PWM_INHC2	PWM_INHC2	R5	22	EPWM13_A
PWM_INLC2	PWM_INLC2	R6	22	EPWM13_B

VSENSE_A2	VSENSE_A2	R238	22	VSENSE_A2_SELECT
VSENSE_B2	VSENSE_B2	R239	22	VSENSE_B2_SELECT
VSENSE_C2	VSENSE_C2	R241	22	VSENSE_C2_SELECT

Axis 2 - SDFM Current Sense

AMC_DOUT1_A2	AMC_DOUT1_A2	R12	22	PRG0_PRU0_SD3_D
AMC_DOUT1_B2	AMC_DOUT1_B2	R14	22	PRG0_PRU0_SD6_D → PRG0_PRU0_SD6_D
AMC_DOUT1_C2	AMC_DOUT1_C2	R16	22	PR0_PRU0_SD7_D → PR0_PRU0_SD7_D

See associated user guide tables for PRU mapping

Axis 2 - Encoder Data Signals

VSENSOR2_SW_EN		R249	22	GPIO1_78_GPIO124
ENCODER_DATA_RX2	ENCODER_DATA_RX2	R20	22	PRG0_PRU1_PERIF2_IN
ENCODER_DATA_TX2	ENCODER_DATA_TX2	R21	22	PRG0_PRU1_PERIF2_OUT
ENCODER_CLK2	ENCODER_CLK2	R22	22	PRG0_PRU1_PERIF2_CLK
ENCODER_DATA_TX_EN2	ENCODER_DATA_TX_EN2	R23	22	PRG0_PRU1_PERIF2_OUT_EN

See associated user guide tables for PRU mapping

DRV SPI Controller MUX

U33 — SN74CB3Q3257PWR

VSYS_3V3 → VCC (16)

SPI_CS0	4	1A	1B1	2 DRV_SCSN1_R R9 22 DRV_SCSN1 → DRV_SCSN1
			1B2	3 DRV_SCSN2_R R10 22 DRV_SCSN2 → DRV_SCSN2
SPI_CLK	7	2A	2B1	5 DRV_SCLK1_R R24 22 DRV_SCLK1 → DRV_SCLK1
			2B2	6 DRV_SCLK2_R R33 22 DRV_SCLK2 → DRV_SCLK2
SPI_D0	9	3A	3B1	11 DRV_SDI1_R R35 22 DRV_SDI1 → DRV_SDI1
			3B2	10 DRV_SDI2_R R36 22 DRV_SDI2 → DRV_SDI2
SPI_D1	12	4A	4B1	14 DRV_SDO1 → DRV_SDO1
			4B2	13 DRV_SDO2 → DRV_SDO2
GPIO1_11_GPIO21	1	S	GND	8 → GND
SPI_MUX_OEN	15	$\overline{OE}$		

GPIO1_11_GPIO21 — R37 1.0k

SPI_MUX_OEN — R38 1.0k

→ GND

VSYS_3V3 → C108 0.1uF → GND

Note: SN74CB3Q3257 MUX defaults
- OE# pulled high - MUX disabled (default)
- S pulled low - path xA <-> xB1 enabled (default)

INPUTS		INPUT/OUTPUT	FUNCTION
$\overline{OE}$	S	A	
L	L	B1	A port = B1 port
L	H	B2	A port = B2 port
H	X	Z	Disconnect

VSENSE/ISENSE Select

ISENSE_A1_SELECT	ISENSE_A1_SELECT	J11	1	SH-J6
ADC0_AIN3_ADC1_AIN0	ADC0_AIN3_ADC1_AIN0		2	
	VSENSE_A2_SELECT		3	
ISENSE_B1_SELECT	ISENSE_B1_SELECT	J13	1	SH-J7
ADC0_AIN4_ADC2_AIN0	ADC0_AIN4_ADC2_AIN0		2	
	VSENSE_B2_SELECT		3	
ISENSE_C1_SELECT	ISENSE_C1_SELECT	J26	1	SH-J8
ADC0_AIN5_ADC3_AIN0	ADC0_AIN5_ADC3_AIN0		2	
	VSENSE_C2_SELECT		3	

PBC03SAAN

Silkscreen:
- Jumper Installed (1-2) - AM263x ISENSE
- Jumper Installed (2-3) - AM243x VSENSE

60900213421

Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 5/22/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00318bbd9d26f2adb001			Sheet: 7 of 17
Drawn By:		File: PROC152_Boosterpack_Header2.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

TEXAS INSTRUMENTS
http://www.ti.com

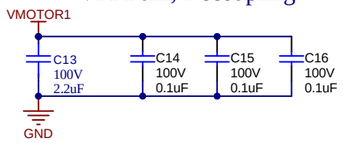
DRV8316: 40-V max 8-A peak 3-phase motor driver with integrated current sensing

Integrated Motor Driver - Axis 1

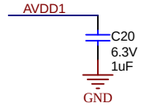
WARNING: 9V-24V Operation
DO NOT EXCEED 48V Input

Note: DRV8316 3.3V buck output in unused, resistor mode.

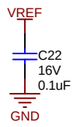
VM Bulk, Decoupling

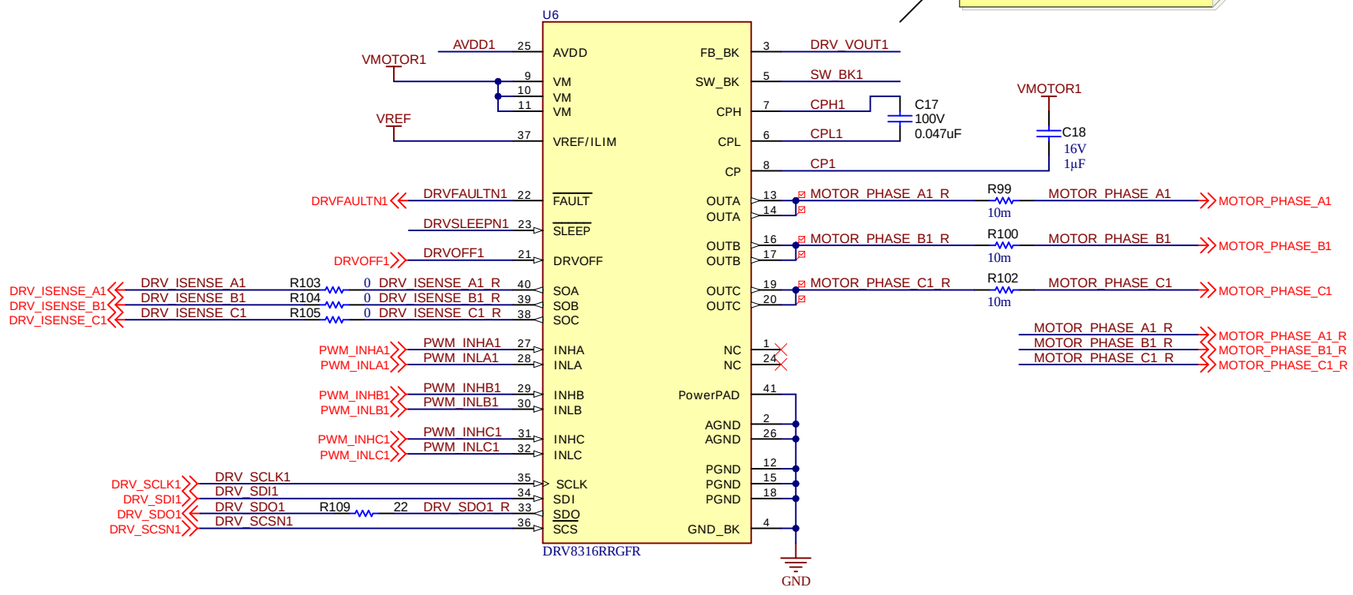


AVDD Decoupling

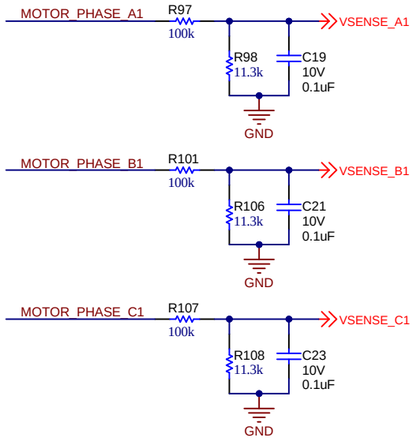


VREF Decoupling



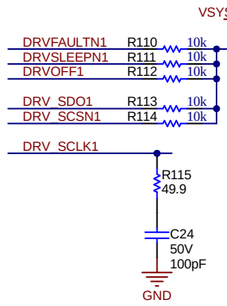


Voltage Sense



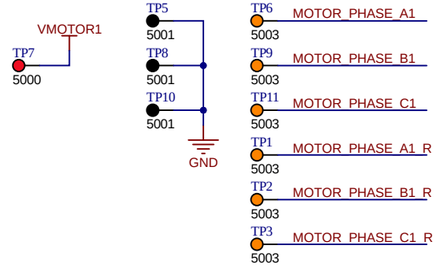
Note:
- Voltage sense: 100k/11.3k divider -> VSENSE_OUT = VSENSE_IN * 0.1015
- 24V input -> 2.436V output

Gate Drive Pull Resistors and Termination

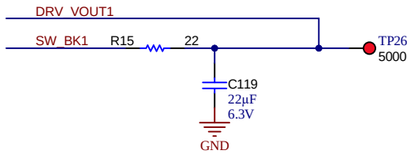


Note:
- DRVOFF# - pulled high disabled by default - controlable from AM2x GPIO
- FAULT# pulled high - sense from AM2x GPIO
- Sleep pulled high - disable sleep by default

Test Points



Buck-Converter (Unused)



Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 5/22/2023
TID #: N/A	Project Title: BP-AM2BLDCSERVO	
Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]001	Sheet: 8 of 17	
Drawn By:	File: PROC152_Motor_Driver1.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

TEXAS INSTRUMENTS
http://www.ti.com

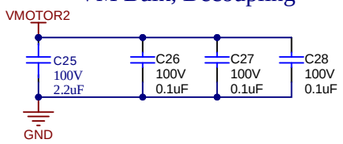
DRV8316: 40-V max 8-A peak 3-phase motor driver with integrated current sensing

Integrated Motor Driver - Axis 2

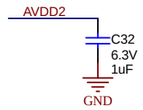
WARNING: 9V-24V Operation
DO NOT EXCEED 48V Input

Note: DRV8316 3.3V buck output in unused, resistor mode.

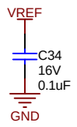
VM Bulk, Decoupling

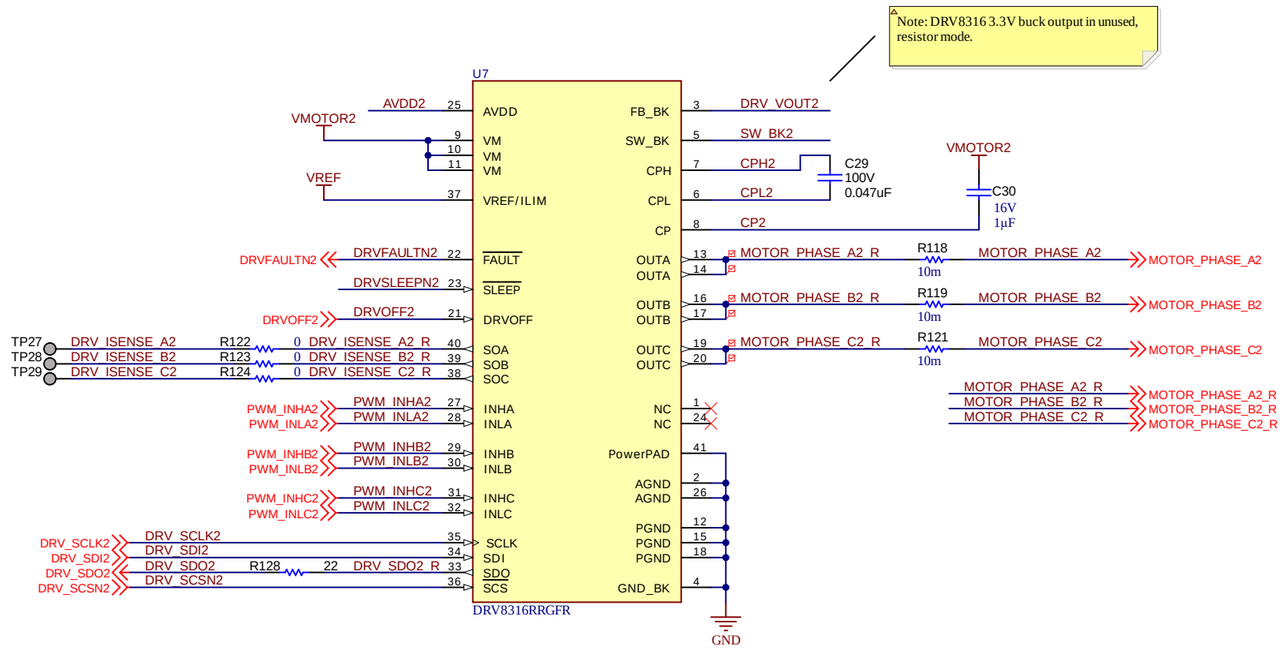


AVDD Decoupling

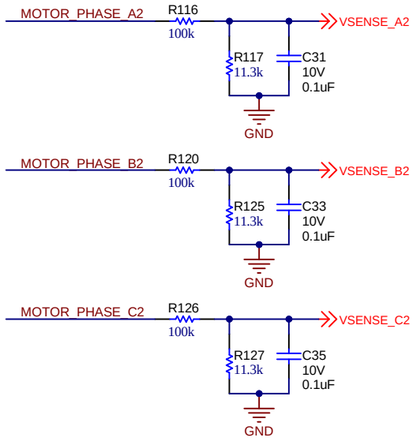


VREF Decoupling



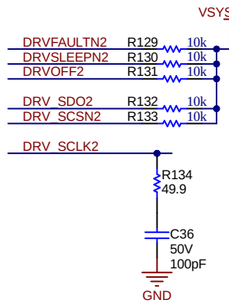


Voltage Sense



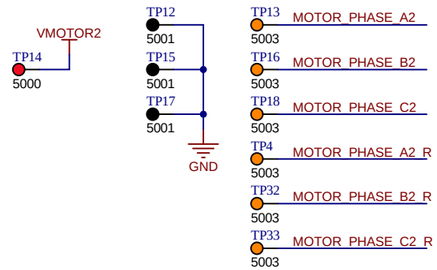
Note:
- Voltage sense: 100k/11.3k divider -> VSENSE_OUT = VSENSE_IN * 0.1015
- 24V input -> 2.436V output

Gate Drive Pull Resistors and Termination

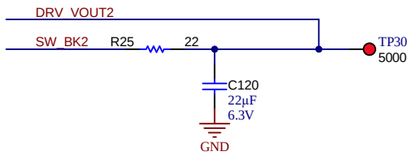


Note:
- DRVOFF# - pulled high disabled by default - controlable from AM2x GPIO
- FAULT# pulled high - sense from AM2x GPIO
- Sleep pulled high - disable sleep by default

Test Points



Buck-Converter (Unused)

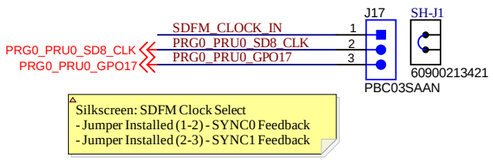


Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/7/2023
TID #: N/A	Project Title: BP-AM2BLDCSERVO	
Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]001	Sheet: 9 of 17	
Drawn By:	File: PROC152_Motor_Driver2.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

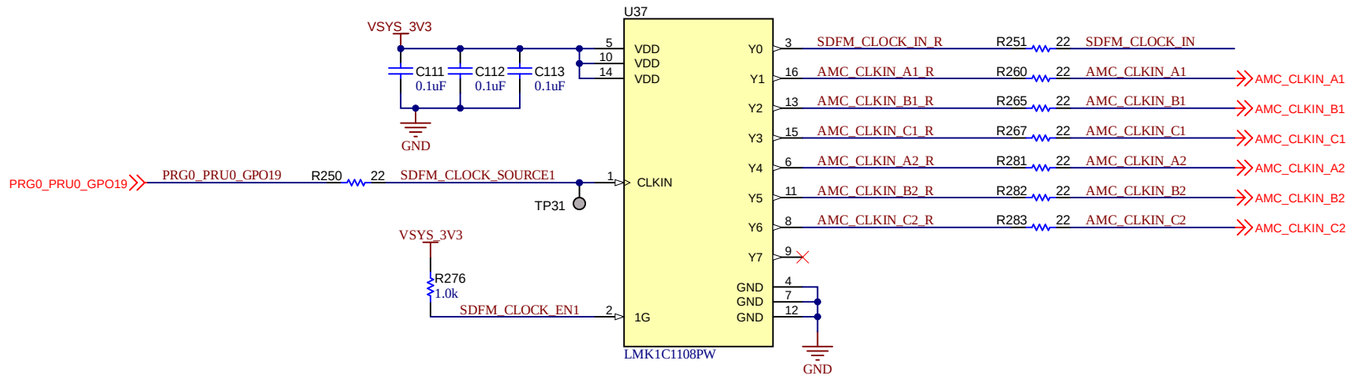
TEXAS INSTRUMENTS
http://www.ti.com

SDFM - Clock Distribution

SDFM Clock Feedback Select



SDFM Clock Source Distribution - Axis 1



Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 6/15/2023
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Number: PROC152 Rev: E2	Sheet Title:	
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Drawn By:	File: PROC152_SDFM_Clock.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

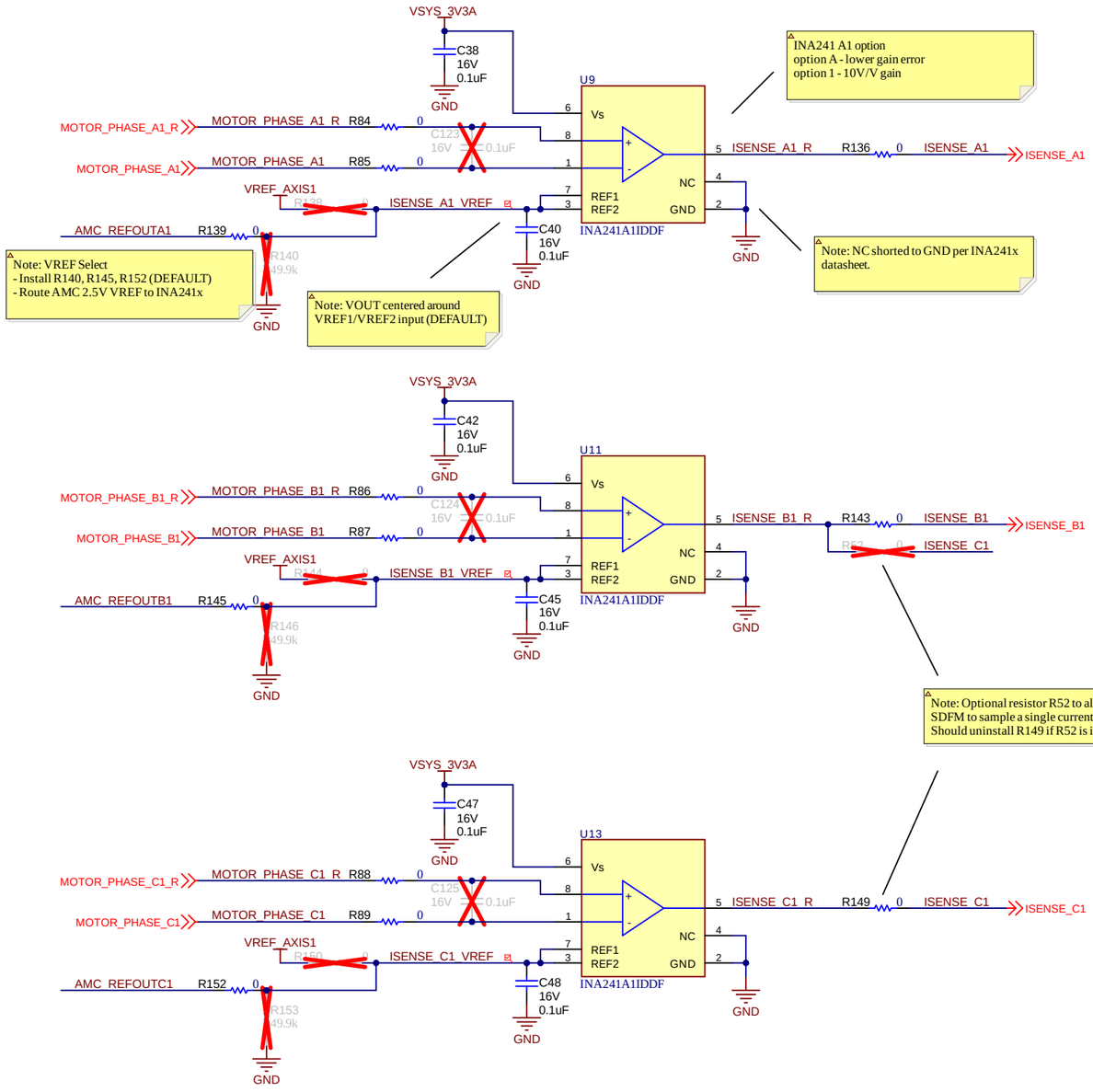
TEXAS INSTRUMENTS
http://www.ti.com

AMC1035D: Precision delta-sigma modulator with ±1-V bipolar input and 2.5-V reference output

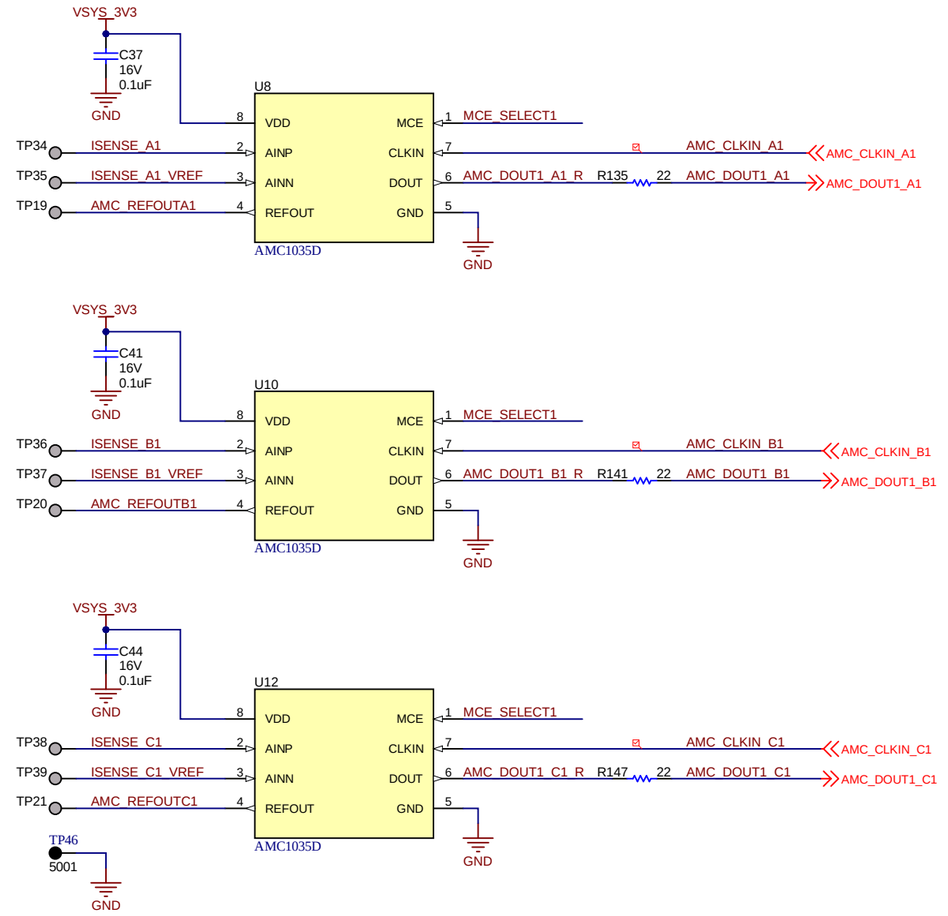
INA241A: -5-V to 110-V bidirectional ultraprecise current sense amplifier with enhanced PWM rejection

Axis 1 - Motor Current Sense

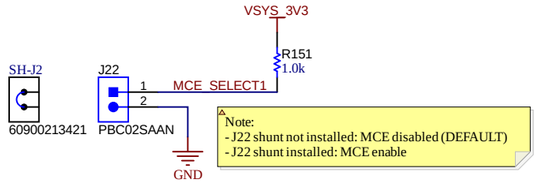
Direct Current Sense



SDFM Current Sense



Manchester Encoding Select



Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/15/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]		[Locally Modified]	Sheet: 11 of 17
Drawn By:		File: PROC152_Current_Sense1.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

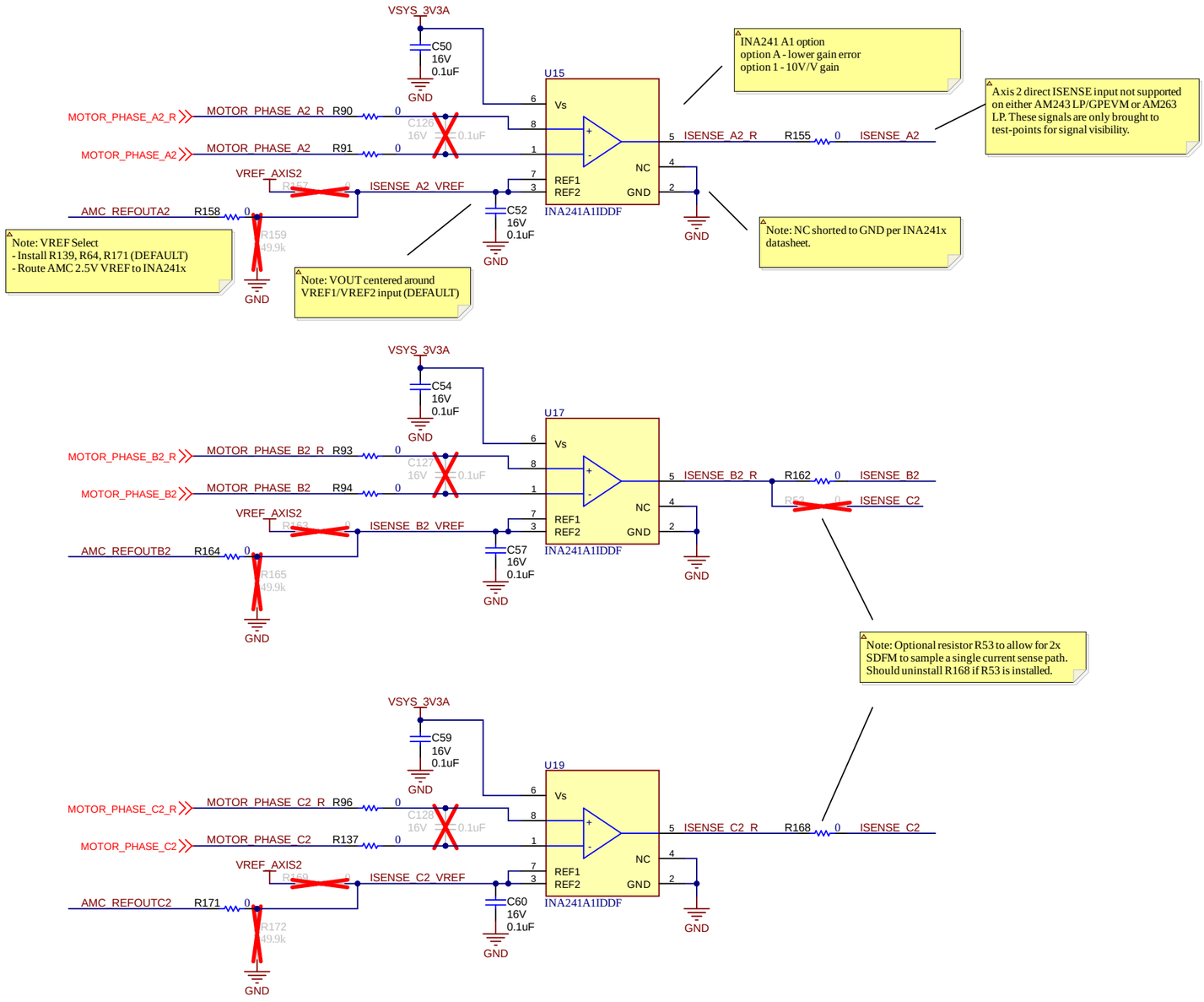
http://www.ti.com

AMC1035D: Precision delta-sigma modulator with ±1-V bipolar input and 2.5-V reference output

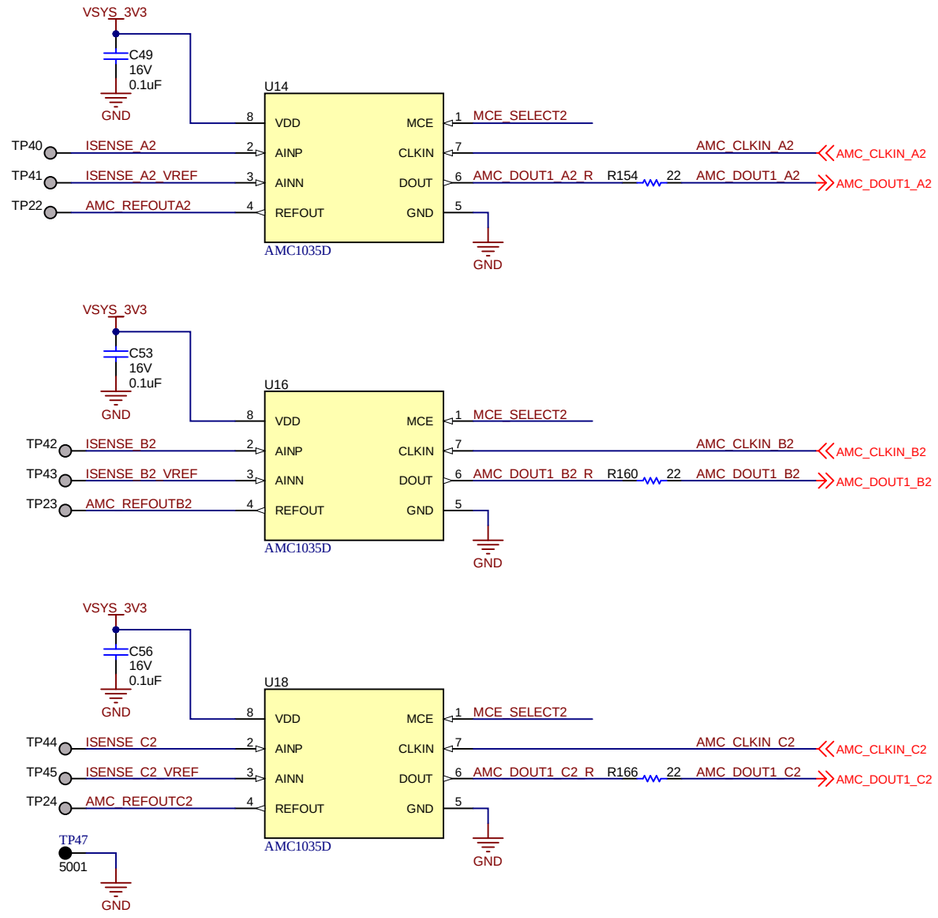
INA241A: -5-V to 110-V bidirectional ultraprecise current sense amplifier with enhanced PWM rejection

Axis 2 - Motor Current Sense

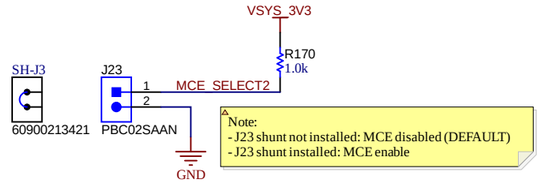
Direct Current Sense



SDFM Current Sense



Manchester Encoding Select

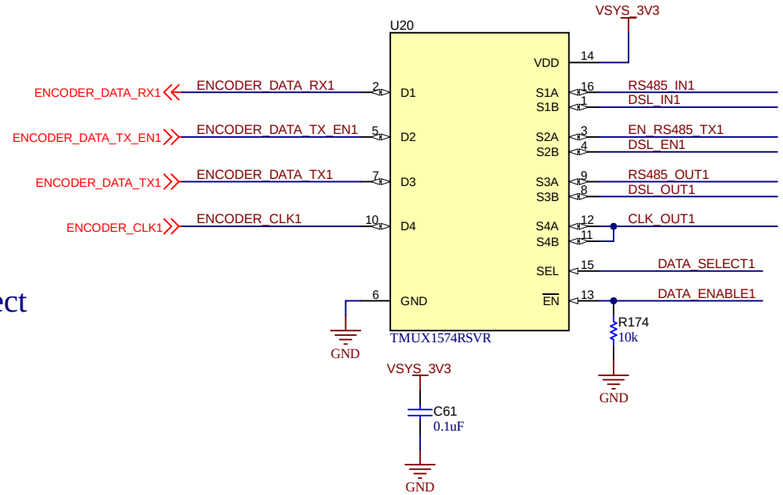


Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/15/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]		[Locally Modified]	Sheet: 12 of 17
Drawn By:		File: PROC152_Current_Sense2.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

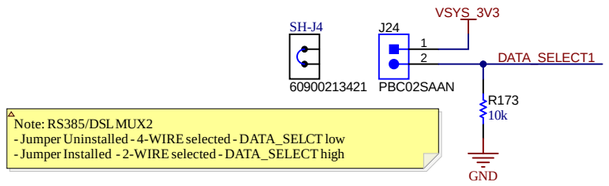
TEXAS INSTRUMENTS
http://www.ti.com

Axis 1 - Encoder Power, RS-485 Drivers

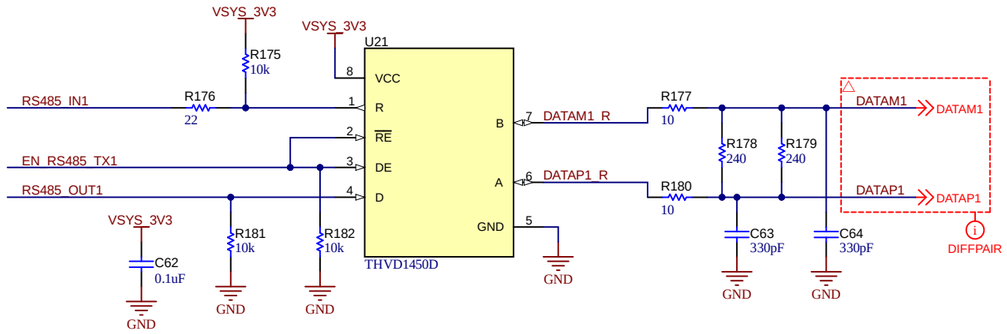
4-Wire Interface MUX



2-Wire/4-Wire Interface Select

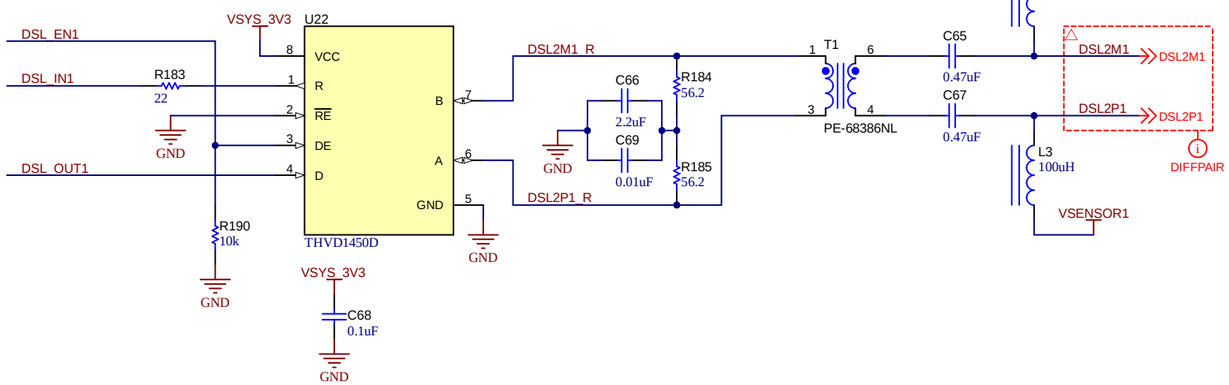


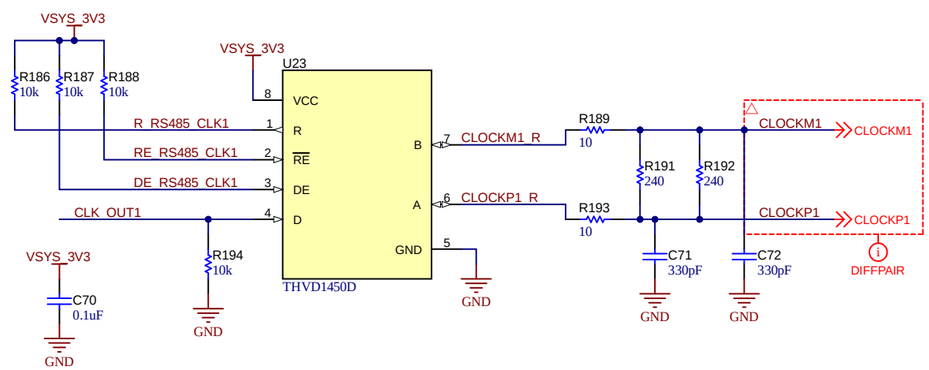
4-Wire Interfaces
RS-485 Transceivers



Hiperface Spec

2-Wire Interfaces





Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 3/7/2023
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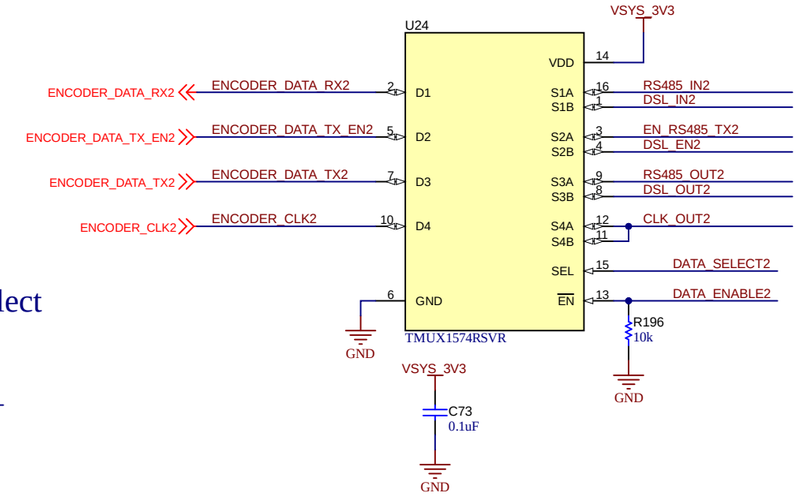
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]001			Sheet: 13 of 17
Drawn By:		File: PROC152_Encoder1.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

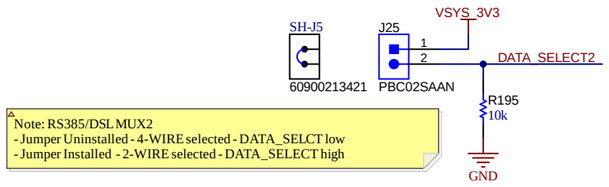
TEXAS INSTRUMENTS
http://www.ti.com

Axis 2 - Encoder Power, RS-485 Drivers

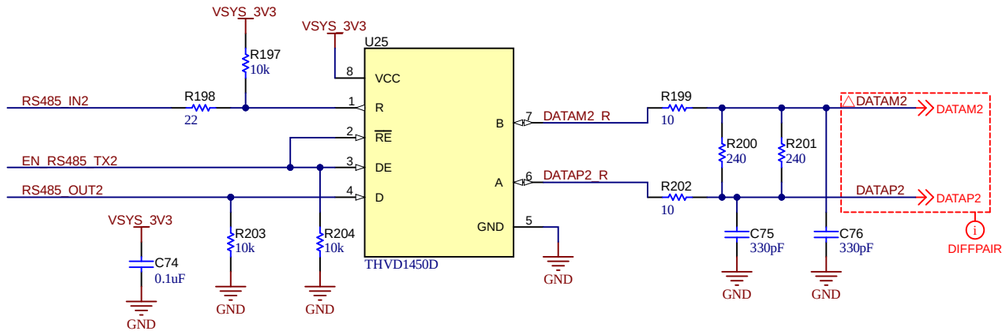
4-Wire Interface MUX



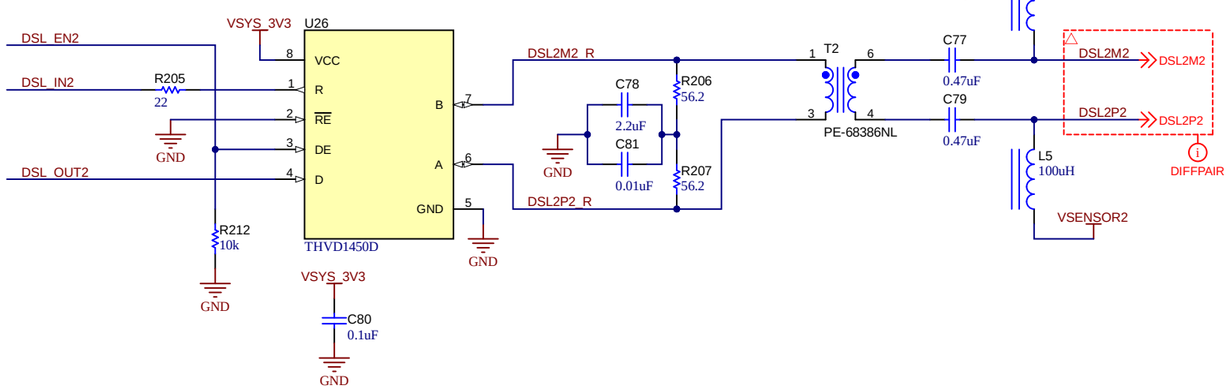
2-Wire/4-Wire Interface Select

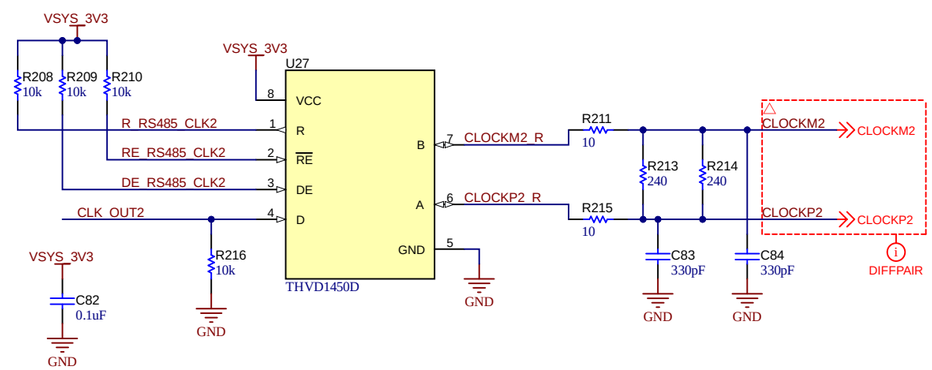


4-Wire Interfaces
RS-485 Transceivers



Hiperface Spec
2-Wire Interfaces



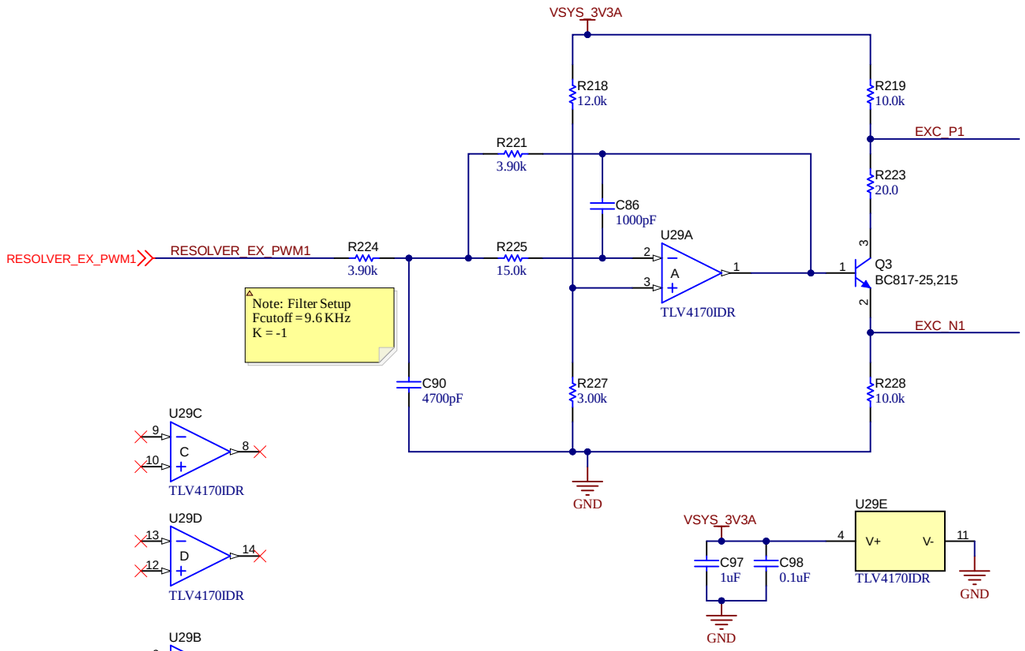


Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/15/2023
TID #: N/A		Project Title: BP-AM2BLDCSERVO	
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]ab001 [Locally Modified]			Sheet: 14 of 17
Drawn By:		File: PROC152_Encoder2.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

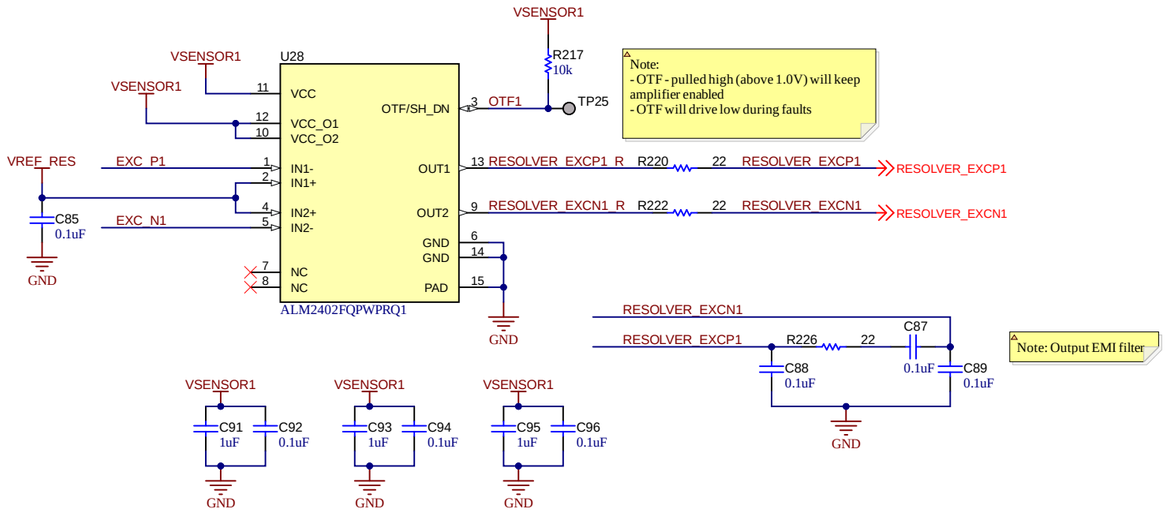
TEXAS INSTRUMENTS
http://www.ti.com

Axis 1 - Resolver Excitation and Feedback

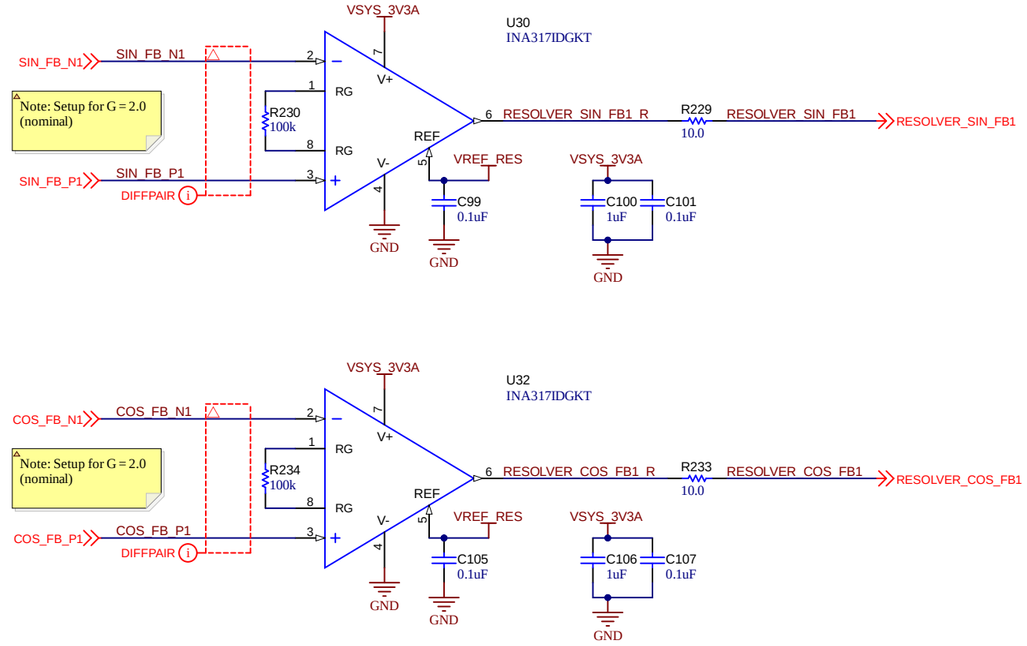
PWM to Sinewave and P/N Phase Splitter



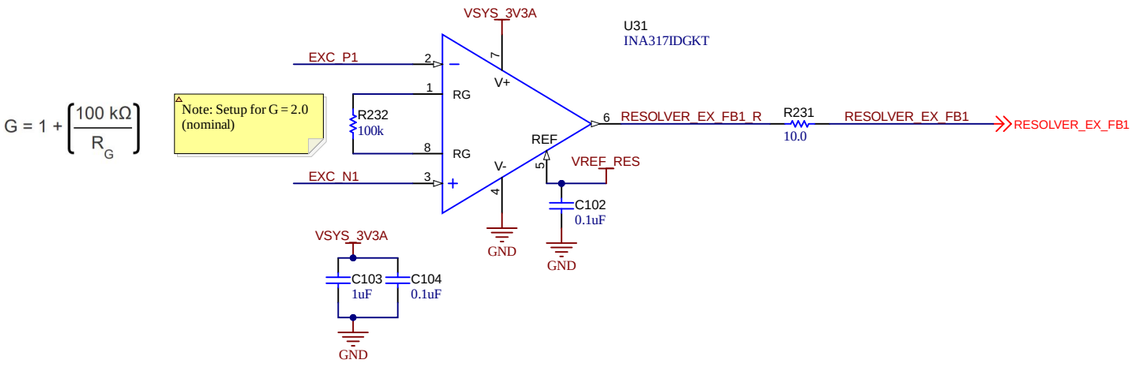
Resolver Excitation Output



Sine/Cosine Feedback



Excitation Feedback



Orderable: ChangeMe in variant		Designed for: Public Release	Mod. Date: 6/10/2023
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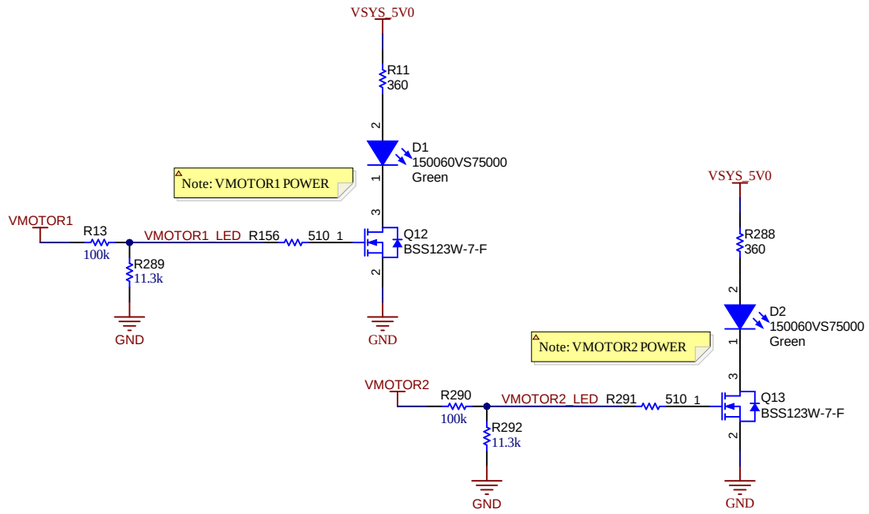
Number: PROC152	Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]1			Sheet: 15 of 17
Drawn By:		File: PROC152_Resolver1.SchDoc	Size: B
Engineer: a0271760		Contact: http://www.ti.com/support	

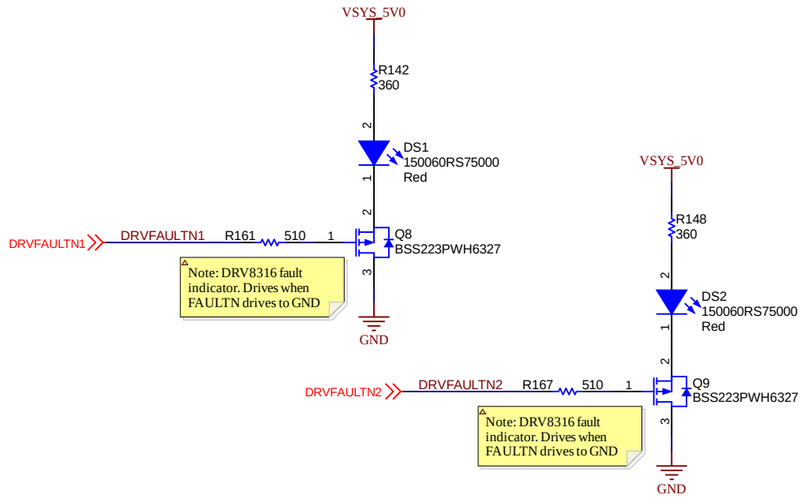
http://www.ti.com

System LED Indicators

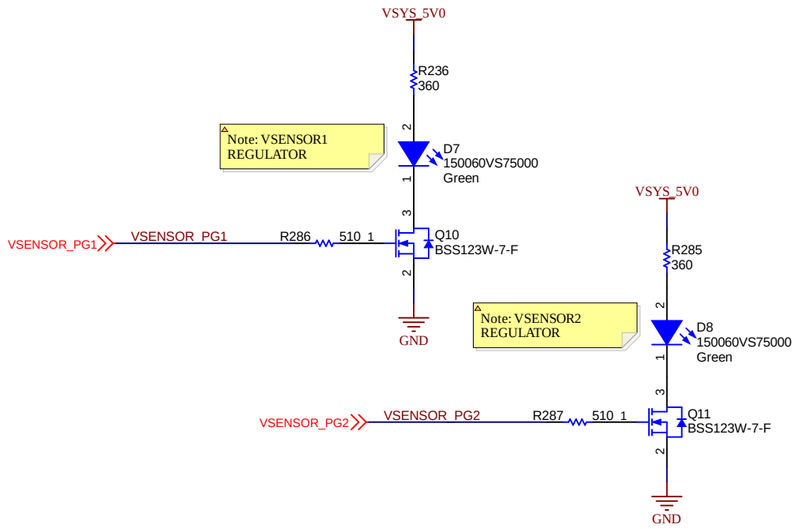
Input Power Indicators



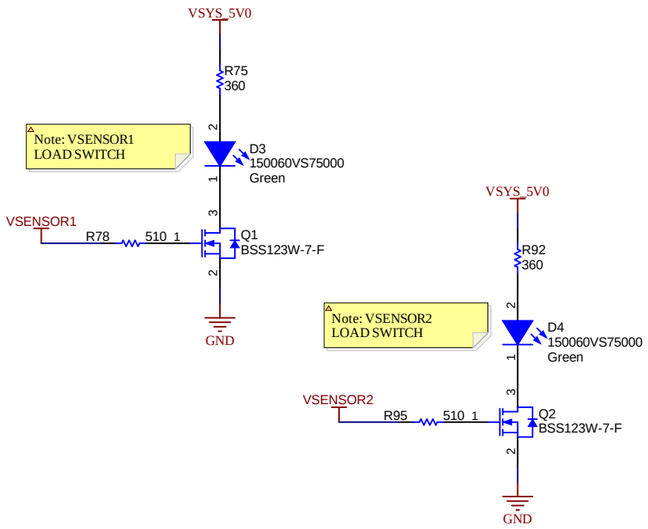
DRV8316 FAULT Indicators



Encoder Regulator Output Indicators



Encoder Load Switch Output Indicators



Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 2/16/2023
TID #: N/A	Project Title: BP-AM2BLDCSERVO	
Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible]01	Sheet: 16 of 17	
Drawn By:	File: PROC152_LED_Indicators.SchDoc	Size: B
Engineer: a0271760	Contact: http://www.ti.com/support	

TEXAS INSTRUMENTS
http://www.ti.com

PCB Number: PROC152
PCB Rev: E2

Logo2
PCB
LOGO
Texas Instruments

Logo1
CE Mark

Logo3
PCB
LOGO
FCC disclaimer

Logo4
PCB
LOGO
WEEE logo

Logo5
PCB
LOGO
Works With TI LaunchPad Logo

Variant/Label Table	
Variant	Label Text
001	Default Variant

LBL1
PCB Label
THT-14-423-10
Size: 0.65" x 0.20 "

ZZ1
Label Assembly Note
This Assembly Note is for PCB labels only

ZZ2
Assembly Note
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3
Assembly Note
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4
Assembly Note
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 6/15/2023
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Number: PROC152 Rev: E2	Sheet Title:	
SVN Rev: 0c65c49446c640714d1d00[illegible] [Locally Modified]		Sheet: 17 of 17
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